International Civil Aviation Organization

Sixth Meeting of the Asia/Pacific Aerodrome Design and Operations Task Force (AP-ADO/TF/6)

Langkawi, Malaysia, 18 - 21 February 2025

Agenda Item 5: Asia and Pacific Regional Guidance on Strength Assessment and Classification for Grassed and Unpaved Runway

DRAFT ASIA/PACIFIC GUIDANCE ON STRENGTH ASSESSMENT AND CLASSIFICATION OF UNPAVED AND GRASSED RUNWAY SURFACES

(Presented by Papua New Guinea, Australia, New Zealand and Nepal)

SUMMARY

This paper presents the first draft of the *Asia/Pacific Guidance on Strength Assessment and Classification of Unpaved and Grassed Runway Surfaces* developed by Papua New Guinea, Australia, New Zealand and Nepal under AP-ADO/TF Task List 5/5.

1. INTRODUCTION

1.1 At the Seventh Meeting of Aerodrome Operations and Planning Sub-group (AOP/SG/7) held in Bangkok on 3 – 6 July 2023 New Zealand presented a paper regarding the strength assessment guidance for unpaved runways in New Zealand and the challenges of promulgating a strength classification for a grass runway.

1.2 The paper highlighted a lack of ICAO guidance on strength assessment for unpaved runways and invited the meeting to consider the need for the establishment of recommended practices regarding unpaved runways. AOP/SG/7 agreed to assign this special task to the Asia Pacific Aerodrome Design and Operation Task Force.

1.3 The 5th Meeting of the Asia Pacific Aerodrome Design and Operation Task Force (AP-ADO/TF/5) held in Chiang Rai, Thailand, from 30th January to 2nd February 2024 recognized the importance of assessment and classifying the strength of unpaved and grassed runway surfaces. AP-ADO/TF/5 endorsed the decision to form a Small Working Group (SWG) comprised of Australia, Nepal and Papua New Guinea to develop a Guidance on Strength Assessment and Classification of Unpaved and Grassed Runway Surfaces for use as a reference document in Asia Pacific Region.

2. DISCUSSION

2.1 In evaluating pavements meant for light aircraft — 5 700 kg mass and less — it is unnecessary to consider the geometry of the undercarriage of aircraft or how the aircraft load is distributed among the wheels. Thus, subgrade class and pavement type need not be reported, and only the maximum allowable aircraft mass and maximum allowable tire pressure need to be determined and reported.

2.2 Classification of pavement bearing strength by the ACR-PCR method is intended for aircraft of mass greater than 5 700 kg and considers the bearing strength of the underlying pavement subgrade. On the contrary, the load from aircraft of mass equal to or less than 5 700 kg has minimal impact on the subgrade and only affects the pavement surface. However, there is a lack of ICAO guidance on strength assessment for unpaved runway surfaces.

2.3 The draft regional guidance (**Attachment A**) includes guidance on classification of runway surface type, bearing capability assessment, inspection and reporting, significant precipitation and risk mitigation. The surface bearing capability assessment guidance covers 3 methods including the aircraft experience method, vehicle-based method, and empirical method.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) review the draft *"Asia/Pacific Guidance on Strength Assessment and Classification of Unpaved and Grassed Runway Surfaces"* provided in the **Attachment A** to this WP; and

b) discuss any relevant matters as appropriate.

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INTERNATIONAL CIVIL AVIATION ORGANIZATION

ASIA PACIFIC REGIONAL GUIDANCE ON STRENGTH ASSESSMENT AND CLASSIFICATION OF UNPAVED AND GRASSED RUNWAY SURFACES

[FIRST DRAFT]

VERSION 1.0 – DECEMBER 20..

This guidance material was developed by the Asia Pacific Aerodrome Design and Operation Task Force (AP-ADO/TF).

It was approved by AOP/SG/(XX – XX December 20xx) and published by ICAO Asia and Pacific Office, Bangkok.

Comments on this guidance material may be sent to ICAO Asia and Pacific Office at apac@icao.int.

RECORD OF AMENDMENTS

AMENDMENTS				AMENDMENTS			
No	Date applicable	Date entered	Entered by	No	Date applicable	Date entered	Entered by

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1. FOREWORD

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1.1.5 The Asia/Pacific Regional Guidance on Strength Assessment and Classification of Unpaved and Grassed Runway Surfaces was developed by the AP-ADO/TF SWG using information derived from Annex 14 Volume I – Aerodrome Design and Operations, Aerodrome Design Manual (Doc 9157), Part 3 — Pavements, CASA Australia AC139.C-07V1.0 Strength Rating of Aerodrome Pavements.

1.1.6 This guidance should be read in conjunction with Chapter 3 of Annex 14, Volume I. It is expected that these requirements should be complied with for unpaved surfaces wherever practicable.

1.2 Background

1.2.1 In some cases, physical attributes of an aerodrome may not be paved but must still be capable of supporting the occasional passage of an aircraft. The natural ground in these instances may not have sufficient bearing strength to handle the aircraft, and therefore

special preparation may be necessary. Adequate strength is required in order to ensure that no structural damage is sustained by an aircraft veering off onto the unpaved surface. The unpaved surface must also be capable of supporting any ground vehicles that may occasionally operate on the area.

1.2.2 The guidance provided in this section is geared toward the physical attributes most commonly left unpaved at an aerodrome. Specifically, these are runway and taxiway shoulders, runway end safety areas (RESAs) and runway strips outside the runway shoulder area. The guidance does not apply to unpaved runways themselves, since the strength requirements for a runway are much more stringent.

1.2.3 For any unpaved surface, the ingestion or jet blast of foreign object debris by aircraft turbine engines is an important consideration. The protection of the surface to ensure no loose material is allowed is the responsibility of the aerodrome. Some type of chemical treatment or the use of turf may be required for the unpaved surface, along with visual inspections, to ensure that foreign object debris is not present.

1.2.4 Attention is drawn to the fact that any bearing strength-related guidance provided in this chapter should in no way be interpreted as a design requirement. Such guidance is only to support the judgment of the engineer when no specific data is available.

1.3 Scope and purpose

1.3.1 The scope of this guidance on the strength assessment and classification of runway surfaces, is limited to aerodromes having unpaved and grassed runways intended for light aircraft of mass equal to or less than 5 700 kg.

1.3.2 The purpose of this manual is to provide guidance on the strength assessment and classification of unpaved and grassed runway surfaces.

1.3.3 This guidance does not include paved surfaces, pavements, ice, compacted snow, or water as surface types.

2. ACRONYMS AND ABBREVIATIONS

ACR — Aircraft Classification Rating

AFM — Aircraft Flight Manual

AIP — Aeronautical Information Publication

NOTAM — Notice to Airmen

PCR — Pavement Classification Rating

POH — Pilots Operating Handbook

RTF — Radiotelephony

3. DEFINITIONS

When the following terms are used in this manual they have the following meanings:

Natural Surface — undisturbed ground surface before excavation or construction

Subgrade — a surface of earth or rock leveled off to receive a foundation

Using Aircraft — the expected capability of the aircraft using the unpaved surface

Using Aircraft Experience — capability

4. CLASSIFICATION OF RUNWAY SURFACE TYPE

4.1.1 The description of the type of runway surface is required to be reported for use by pilots to correct the effective operational length.

4.1.2 The following is a list of the standard terminology to be used in describing an unpaved runway surface. Only one term can be used when reporting the description of an unpaved runway surface:

Surfaces	**Abbreviation**	**Note**
Coral	CR	
Firm Grass	GR(f)	
Grass	Gr/GRASS	
Gravel	GRVL	
Gravel (stabilised)	GRVL(st)	
Primed gravel	PRIME	Bitumen, oil or tar bound pavements with no stone cover.
Natural Ground Surface	NS	undisturbed ground surface before excavation or construction
Sand	SA	
Soft Grass	GR(s)	
Snow and compacted snow	SN	

5. ASSESSMENT OF BEARING CAPABILITY OF UNPAVED RUNWAY SURFACE

5.1 Strength of runways

5.1.1 Annex 14 Volume I, paragraph 3.1.21 recommends that the runway should be capable of withstanding the traffic of aeroplanes the runway is intended to serve.

5.1.2 The following subsections provide three methods which may be applied to an unpaved runway surface. It is up to the responsible state or aerodrome operator to determine which method, or an alternative means, is most suitable for the intended operation.

5.2 Using aircraft experience (intended aircraft)

5.2.1 This method relies upon the operational experience of aircraft utilizing an existing runway surface.

5.2.2 Note: This method is very simple to use however the limitations below need to be understood first before it is applied

5.2.3 This method is not recommended for aircraft with an apron (ramp) mass greater than 5 700 kg. In these cases, a technical evaluation should be used to more accurately define the bearing strength properties of the surface. Refer subsection 5.4.

5.2.4 This method also relies upon previous experience which may not be reflective of future performance. For example, an existing aircraft type may have successfully used an unpaved surface however its strength may have been compromised through repeated use. Environmental conditions, the absorption of water, temperature variability, soil reactivity and other factors such as any depression, distress and undulation of the surface could make a previously suitable surface no longer serviceable for the intended operation.

5.2.5 Aircraft factors, including its mass, tyre pressure, braking application and takeoff/landing speeds can also impact upon the performance of the unpaved runway surface and need to be considered.

5.2.6 To mitigate against this potential hazard, regular inspections should be undertaken of the surface. Refer subsection 6.1.

5.2.7 To use this method:

5.2.8 **Step 1:** Select the intended aircraft type based upon the desired or expected use of the existing unpaved runway surface.

5.2.9 **Step 2:** Obtain the maximum take-off weight and tyre pressure(s) for the selected aircraft. This information can generally be located from the Pilots Operating Handbook (POH), the Aircraft Flight Manual (AFM) or officially published technical data from the aircraft manufacturer.

5.2.10 **Step 3:** Publish these technical parameters for the unpaved runway surface in Aeronautical Information Publication (AIP) or another suitable document.

5.2.11 This method can also be used in conjunction with the vehicle-based method, or other evaluative or empirical methods.

5.3 Vehicle-based method

5.3.1 An aircraft can land anywhere between the cone markers, not necessarily along the centre-line. If the aircraft strikes a soft spot at high speed it is most likely to lose directional control or front wheel assembly will be torn off and result in nosing over.

5.3.2 The vehicle-based assessment method for indicating the bearing capability of a runway surface involves the simulation of impact an aircraft may cause to the runway surface by using a test vehicle of correlating weight as shown in the table below.

Type of aircraft	**Test vehicle**
Light single aircraft Bonanzas, Cessnas etc	Light laden 3 tonne truck with repetitive passes in wet areas
Medium twins such as Aero Commander, Baron Twin-otter, Cessna 421, Kingair etc.	Fully laden 3 tonne truck with repetitive passes in wet and moist areas associated with your experience of aircraft using the aerodrome
Heavier aircraft such as F27, Caribou, DC3 etc	Fully laden 5 tonne truck with repetitive passes in moist and wet areas

5.3.3 A test vehicle as indicated should be driven in a zigzag pattern at a speed not exceeding 15 km/hr for the full length and width of the runway. Particular attention should be paid to suspect areas with possibly three passes of the test vehicle over these areas. If tyre imprints exceed a depth of 25mm, the surface is not suitable for aircraft operations particular to the test vehicle. Unnecessary cutting up of the surface is to be avoided because imprints are hard to remove when the surface has dried out. In some instances, the surface may be unsafe with a lesser imprint and this is at the discretion of the inspecting officer.

5.3.4 Remember that the above test may leave wheel ruts, which will need to filled in later before the runway can be reopened for aircraft movement.

5.3.5 Because the 5 700 kg limit for light aircraft represents pavement loads only two-thirds or less of common highway loads, the assessment of traffic using pavements should extend to consideration of heavy ground vehicles, such as fuel trucks, fire trucks, snow ploughs,

service vehicles, etc. These must also be controlled in relation to load limited pavements *(Doc 9157 Aerodrome Design Part 3 – Pavements, clause 3.5.12).*

5.3.6 To test for slippery condition, any 4-wheel drive vehicle may be used, but it is necessary to use the same or similar vehicle throughout the test. During dry conditions the vehicle is driven over the runway at 50 km/hr and the brakes applied to lock all four wheels. The length of skid is measured and recorded. During wet conditions the operation is repeated and the length of skid measured. If this dimension exceeds 1.5 times the recorded dry skid distance the surface is considered to be unacceptably slippery.

5.3.7 The test for rough surface condition is to drive a stiffly sprung vehicle such as a Land Rover, without discomfort to the passengers, at a speed not less than 75 km/hr for the central 30m, and not less than 50 km/hr for the remainder of the runway strip. The maximum allowable width of cracks and size of stones permitted is 25mm within the central 30m and 50mm for the remainder. If there is a soft wet condition within the runway strip area, the entire direction must be closed if it is unacceptably rough.

5.4 Empirical method

Paved surfaces

5.4.1 The bearing strength of a pavement intended for aircraft of apron (ramp) mass equal to or less than 5 700 kg shall be made available by reporting the following information *(Annex 14 Volume I, 2.6.8)*:

a) maximum allowable aircraft mass; and
b) maximum allowable tire pressure.

Example: 4 000 kg/0.50 MPa

5.4.2 Light aircraft are those having a mass of 5 700 kg or less. These aircraft have pavement requirements less than that of many highway trucks. Technical evaluations of those pavements can be made but an evaluation based on “using aircraft” is satisfactory. It is worth noting that, at some airports, service vehicles such as fire trucks, fuel trucks or snow ploughs may be more critical than aircraft. Since nearly all light aircraft have single-wheel undercarriage legs, there is no need for reporting subgrade categories. However, since some helicopters and military trainer aircraft within this mass range have quite high tire pressures, limited quality pavements may need to have tire pressure limits established *(Doc 9157 Aerodrome Design Part 3 – Pavements, clause 3.3.6).*

5.4.3 In evaluating pavements meant for light aircraft — 5 700 kg mass and less — it is unnecessary to consider the geometry of the undercarriage of aircraft or how the aircraft load is distributed among the wheels. Thus, subgrade class and pavement type need not be reported, and only the maximum allowable aircraft mass and maximum allowable tire pressure need to be determined and reported. For these, the foregoing guidance on techniques for “using aircraft” evaluation should be followed *(Doc 9157 Aerodrome Design Part 3 – Pavements, clause 3.5.11).*

Unpaved surfaces

5.4.4 Due to the nature of unpaved surfaces, an empirical method for assessing the bearing capability has inherent limitations. An unpaved or natural surface may not have a consistent bearing capability across the entire surface; therefore, consideration should be made for developing a process that considers the capability of the surface so far as reasonably practicable. Additionally, prevailing weather conditions may significantly affect the capability of the runway.

5.4.5 One example of a bearing capability assessment is the use of a Dynamic Cone Penetrometer[1] which can generate a strength estimate of the surface.

5.4.6 An aerodrome operator should develop an assessment process that includes sufficient measurements to develop an appreciation of the capability of the entirety of the unpaved runway and the associated surfaces that should be load-bearing.

5.4.7 An aerodrome operator should engage with aircraft operators to ensure aircraft operators understand the capability data of the runway, and the conditions in which the measurements were taken. With the assistance of subject-matter experts, operators should agree the criteria under which the runway is considered usable for a design aircraft, or for aircraft specific to operators.

[1] https://apps.dtic.mil/sti/pdfs/ADA281985.pdf

6. INSPECTION AND REPORTING PROCESS

6.1 Inspections of unpaved surfaces

6.1.1 Inspections of the movement area should be planned to ensure that an appropriate level of vigilance is maintained at all times.

6.1.2 The inspection of unpaved surfaces should cover, at a minimum, the following items:

a) the runway;

b) the remaining manoeuvring area, including taxiways and adjacent areas;

c) the apron and service areas as applicable;

6.1.3 During the inspection, particular attention should be given to:

a) surface conditions including signs of damage or distress;

b) detection of FOD or other surface contamination

c) detection of surface depressions, rutting or undulation

d) detection of areas with a weaker surface strength including mud, sinkholes, standing water, erosion, etc.

e) The general condition of the surface grass/vegetation, particularly any areas of blast. Rotor wash or prop wash erosion

f) the grass length including any weed growth.

6.1.4 Ideally, a first inspection should be conducted prior to daily operations. Subsequent inspections should also be undertaken in the event of:

a) Significant precipitation or snow;

b) High winds;

c) Otherwise following an extreme or seasonally uncommon weather event.

6.1.5 A log should be kept recording the results of the inspection.

6.2 Reporting of unpaved surface condition

6.2.1 If a dangerous or otherwise hazardous unserviceability is discovered during an inspection it should be immediately reported.

6.2.2 If a NOTAM service is available at the aerodrome, it should be used to advise aircraft operators and other stakeholders of the change to aerodrome condition or capability.

6.2.3 If a radiotelephony (RTF) service is available and the reporter is sufficiently qualified and experienced to use such equipment, the provision of advice via RTF to any arriving or departing aircraft should be considered.

6.2.4 The entity in charge of aerodrome operations should also be informed.

6.2.5 Consideration should also be given to updating any published information, such as in AIP or other operational documents.

7. RISK MITIGATION

7.1.1 If there is any doubt as to the serviceability of an unpaved runway surface, appropriate mitigation options should be immediately considered to protect aircraft operations.

7.1.2 This may include but not be limited to the following:

a) The affected runway, taxiway and/or apron should be restricted or closed to aircraft operations until the conditions improve.

b) Visual aids in the form of unserviceability markers should be used to alert pilots of the restricted or closed portion of the movement areas.

c) If the unpaved surface is available for nighttime operations, any lighted visual aids should be extinguished or covered so that they are no longer visible.

d) Vehicles and person should avoid driving on the unserviceable areas as they may become stranded or may exacerbate the surface condition.

7.1.3 Once the conditions return to a serviceable state, the closed or restricted areas can be returned to service, visual aids removed/reinstated and appropriate reports made as to the aerodrome condition.

REFERENCES

1) ICAO Annex 14, Volume I

2) PANS-Aerodromes (Doc 9981)

3) Aerodrome Design Manul (Doc 9157), Part 3

4) CASA Australia AC139.C-07V1.0 Strength Rating of Aerodrome Pavements

5) New Zealand ……